Standard Pol and Standard WL Pol microscopes

Operating Instructions

G 41 - 506 - e

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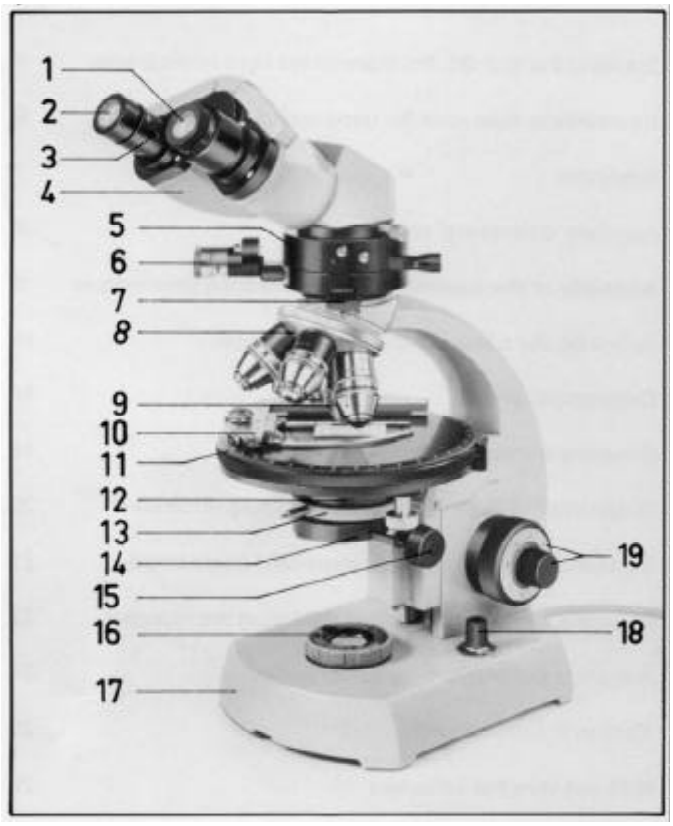

Fig. 1: Standard 18 Pol polarizing microscope (49 10 38) for orthoscopic and conoscopic binocular observation

1 Kpl wide-angle, high-eyepoint, focusing eyepiece 12.5x/18 Br foc (46 41 43-9902) [1)]
2 Kpl wide-angle eyepiece 12.5x/18 Pol Br with crossline micrometer (46 41 45)
3 Alignment screw of Pol eyepiece engaged in a tube notch. When the alignment screw of the Pol eyepiece engages the horizontal notch in the edge of the left or right tube, the horizontal crossline bar will be aligned parallel with the oscillation direction of the plarizer (0° position/East-West), the vertical one parallel with that of the analyzer (North-South).
The crosslines will be diagonal to these osciallation directions when the orienting screw engages the 45° displaced notch.
4 Binocular tube S/30° Pol (47 30 36) with lever mechanism which keeps tube length and crossline orientation constant when the tubes are set to the user's PD.
5 Intermediate tube (47 30 56) with swing-in Bertrand optics (see p. 6)
6 Rotary analyzer in slider (47 36 62-9903)
7 Auxiliary object or compensator
8 Quintuple glide nosepiece (47 31 50) exchangeable for centerable change slide for single objectives (47 31 11) or epi-condenser
9 Strain-free Pol Z objectives in centering mount
10 Attachable mechanical stage Pol (47 33 25-9903) to move the specimen within a 30 x 40 mm area
11 Large rotary polarizing stage (47 34 66) with graduation, vernier, clamp, 45° click-stop system and lockable rotary knob
12 Condenser 1.3 with swing-out front lens Z Pol (46 52 63) and screw-in auxiliary lens EL Pol (46 51 44)
13 Vertically adjustable condenser carrier with centering screws
14 Carrier with non-rotary, swing-in polarizer (47 08 66); oscillation direction East-West
15 Control for vertical condenser adjustment
16 Luminous-field iris diaphragm setting ring; holder for 32 mm dia. filters inside the ring
17 Stand base with in-base 6 V 10 W halogen illuminator and transformer
18 Power switch and brightness control of 6 V 10 W halogen illuminator
19 Coarse/fine focusing control; one interval of the fine-control graduation corresponds to 5 μm = 0.005 mm vertical stage movement.

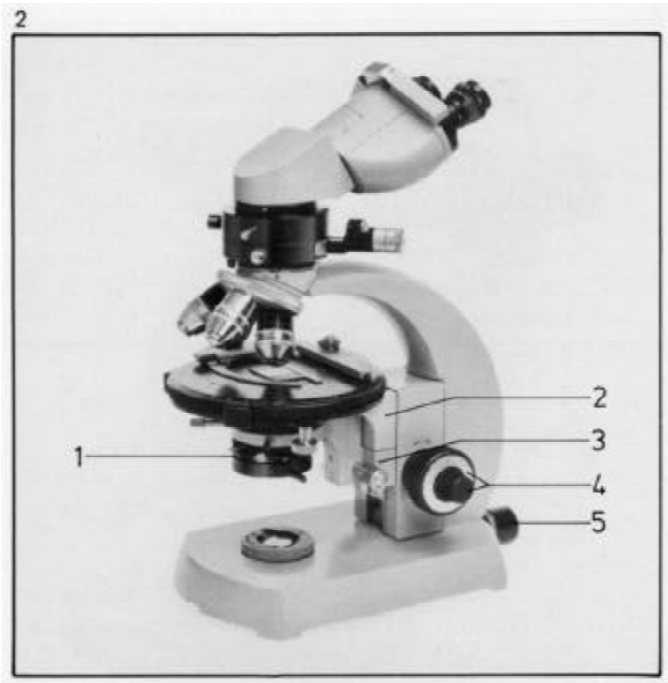

Fig. 2: Standard WL Pol microscope (49 15 59) for orthoscopic and conoscopic binocular observation

Microscope parts which are different for Standard WL Pol and Standard Pol (Fig. 1) microscopes:

1 Swing-in carrier with rotary polarizer and swing-out auxiliary lens (47 08 65-9902); the polarizer mount is graduated in 15° intervals with click stops at 0° and 90°. In normal position (click stop 0°) the oscillation direction is East-West. Readout on the operating knob.
2 Attachable stage carrier (47 15 40) with rotary polarizing stage (47 34 66)
3 Attachable condenser carrier (47 15 58-9901) with centering screws
4 Coarse/fine focusing controls which act on the specimen stage independently of each other
Note: Before first use of the operating controls remove the transport lock by lifting the rack-and-pinion box with the aid of the coarse focusing controls and remove the plastic plate.
5 6 V 15 W in-base illuminator

All optical components between polarizer and analyzer (condenser, objectives) contain strain-free lens elements and bear the red engraving "Pol".

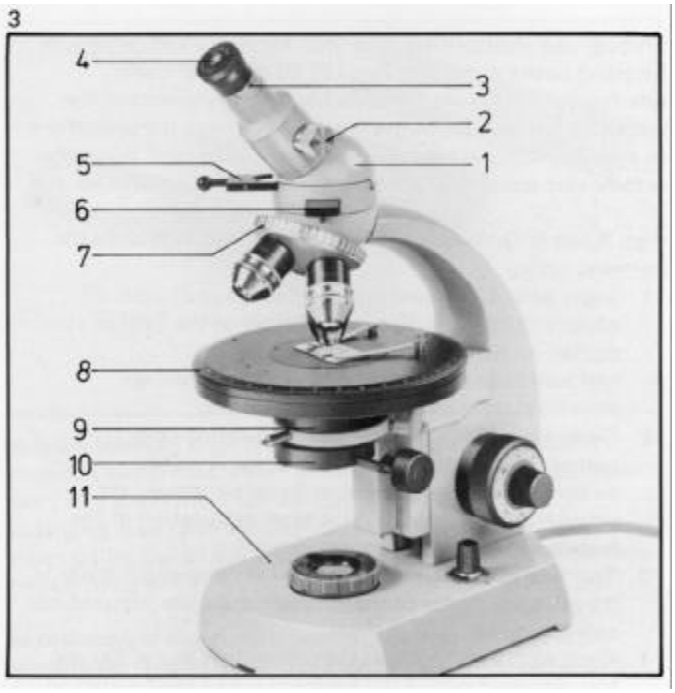

Fig. 3: Standard 16 Pol microscope for orthoscopic and conoscopic monocular observation

1 Monocular polarizing tube (47 30 30-9905) with analyzer
2 Operating knob for Bertrand lens and diaphragm for conoscopic observation
3 Alignment screw of Pol eyepiece engaged in horizontal notch of tube edge (see 1.3, meaning Fig. **1**, item 3)
4 Kpl crossline eyepiece 8x Pol (46 39 25)
5 Analyzer is in the beam path when the slider is completely pulled out
6 Auxiliary object or compensator
7 Nosepiece with 5 Pol Z objectives
8 Rotary polarizing stage (47 34 64) with graduation, vernier and clamp
Two stage clips (47 33 73) to secure the specimen
9 Condenser 0.9 Z Pol (46 52 62) with swing-out from lens and screw-in auxiliary lens EL Pol (46 51 44)
10 Non-rotary, swing-out polarizer on carrier (47 08 66); oscillation direction East-West
11 Stand base with in-base 6 V 10 W illuminator and in-base transformer

Microscope parts such as focusing controls (**1.19**) and knob (**1.18**) correspond to those of the Standard 18 Pol microscope (Fig. **1**).

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[1] The 6- or 10-digit numbers in brackets are ordering numbers; they are imprinted on some items or modules.

Intermediate tube with Bertrand optics and diaphragm

Through the intermediate tube with focusable and centerable Bertrand optics and diaphragm (47 30 56) conoscopic interference figures are made visible in the eyepieces of the binocular Pol tube or images projected through the phototube to a photomicrographic or TV camera. Conoscopic image and orthoscopic surrounding field can be observed simultaneously.

Figs. 4 and 5: Operating controls of intermediate tube with Bertrand optics

1 Slider with 3 Bertrand pinhole diaphragms to cut off objects of different size in the center of the field of view
pushed in: maximum diaphragm opening
half way in or out: medium diaphragm opening
pulled out: minimum diaphragm opening

2 Slider with diaphragm for the surrounding field
pushed in: only the conoscopic image is visible
pulled out: consocopic and orthoscopic images are simultaneously visible, which eases localization of the feature to be studied conoscopically

3 Two hex socket screws to center the conoscopic image in the crossline center of the eyepiece using the supplied hex socket wrench

4 Knob with scale to focus the conoscopic image. Certain focusing positions of the Bertrand optics can be marked with the aid of the scale

5 Slider to operate the Bertrand optical system
pushed in: Bertrand optics operative (conoscopic observation)
pulled out: Bertrand optics inoperative (orthoscopic observation). In this position slider (2) must also be pulled out to make the entire orthoscopic field of view visible.

6 Analyzer slider clamping screw prevents the slider from being pulled out accidentally and secures the set position of the slider

7 Analyzer

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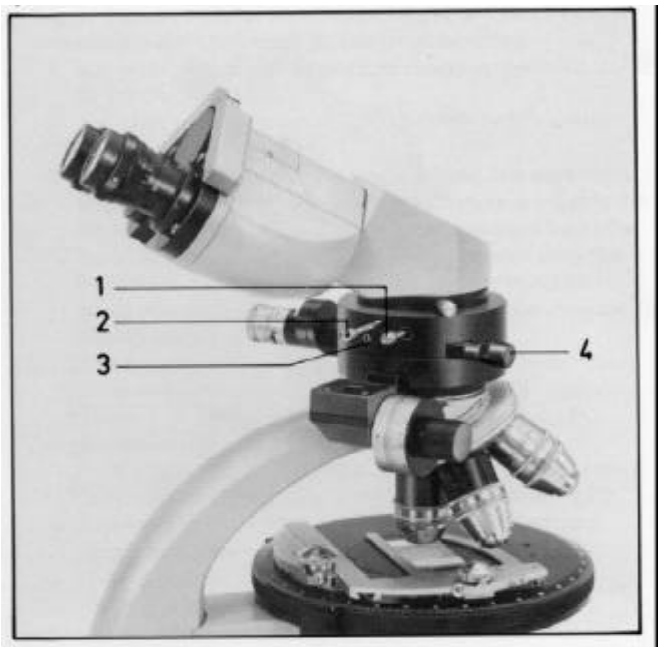

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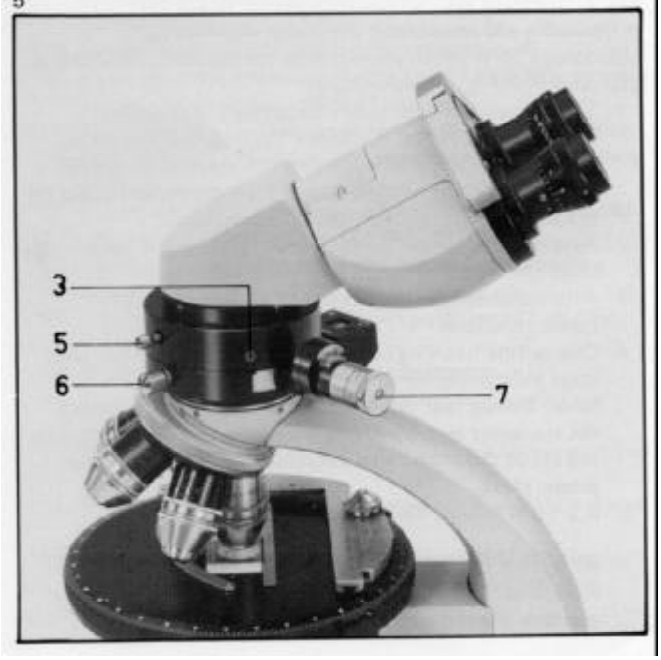

Analyzers

Auxiliary objects and compensators

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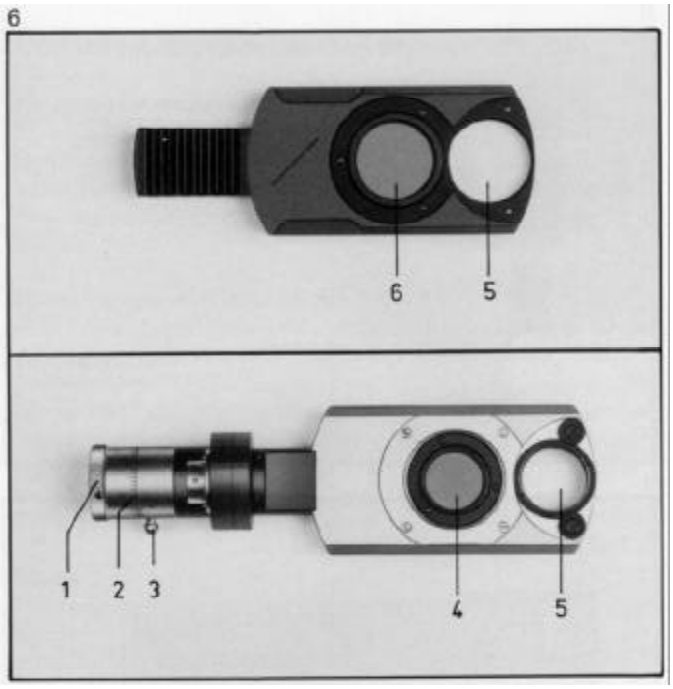

Two different analyzers are contained in a slider.
Analyzer (47 36 62-9903) (**6**.4) is rotary. Its angle of rotation can be read to within 1/10° on the 360° graduation with vernier and clamped with lever (**6**.3). When turning knob (**6**.1) towards higher numbers, analyzer (**6**.4) rotates counterclockwise (mathematically positive). When set to 90° the oscillation direction of the analyzer (North-South) is thus crossed with that of the polarizer.
Analyzer (47 36 63-9903) (**6**.6) is non-rotary and firmly set to 90° position.
When the analyzer is pulled out of the beam path, a plane-parallel optical element in slider (**6**.5) takes its place in the beam path. It suppresses disturbing polarization effects due to beam-splitting or reflecting elements above the analyzer slider (analyzer effects), and avoids the simulation of the pleochroism which does not exist in the object.

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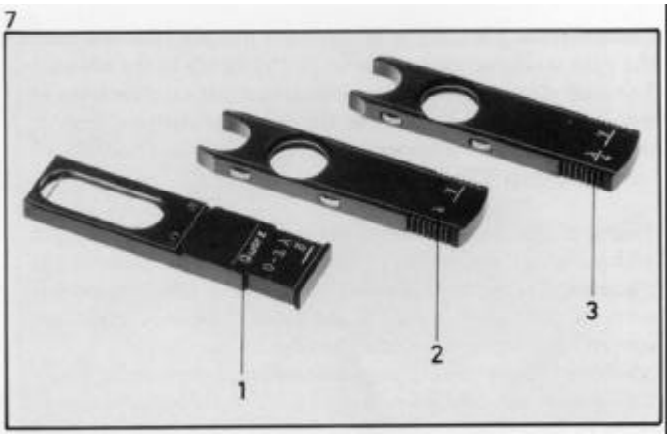

Aligned auxiliary objects and compensators are contained in sliders and are slid either in the standard-sized compensator slot (20 x 6 mm) (**1**.7) of the intermediate tube or of the polarizing tube (**3**.6) between crossed polarizer and analyzer. When pulled out of the beam path the compensator slider may remain in its slot.

In **orthoscopic observation** auxiliary objects are used to determine the relative amounts of the refractive indices of birefringent objects, i.e. to determine which of the refractive indices, the higher ($n\gamma'$) or the lower one ($n\alpha'$) belongs to which principal oscillation direction.

In **conoscopic observation** the sign of the optical character of the indicatrix of anisotropic objects (optically positive or negative) can be determined with the aid of auxiliary objects.

Auxiliary object λ (47 37 04) (7.2) enlarges or reduces by 550 nm the phase differences of the wave pairs coming from the object. **Auxiliary object λ/4 (47 37 14) (7.3) changes the phase difference by ca. 140 nm.**
The auxiliary object has a NO-SW γ-direction. When the γ'-direction of the object is parallel with the γ-direction of the auxiliary object, the two phase differences sum each other (addition position). The object will appear in a "higher" interference color.
When the γ'-direction of the object is at right angles to the γ-direction of the auxiliary object, the two phase differences subtract each other (subtraction position). The interference color of the object will be "lower" by the phase difference of the auxiliary object.

Quartz wedge 0 – 3 γ (47 37 24) (7.1.) is used for objects having greater phase differences. By moving the quartz wedge in the compensator slot, the interference colors of the object are continuously varied by max. three orders towards "higher" or "lower" values (depending on the addition or subtraction position).

Compensators are used to measure the phase differences of the light waves which are due to birefringence in the object. For such measurements the principal oscillation directions of the object must be diagonal to the crossed polarizers. For more details of the compensators see the relevant operating instructions (p. 27).

Tilting compensators feature either a birefringent plane plate which can be tilted about a horizontal axis, or two cemented plane-parallel plates in subtraction position. When measuring with the compensator B or E, the phase difference from the sum of both tilting angles can be directly read off the table contained in the corresponding operating instructions. The tilting angle can be read to within 0.05° on the graduated drum of the compensator.

Tilting compensator B (41 37 40) (Fig. 8)
to measure phase differences up to ca. 5 orders (5 λ)

Tilting compensator E (41 37 41)
to measure phase differences up to ca. 20 orders (20 λ)

Rotary compensators for small phase differences
contain a birefringent plane plate which can be rotated about the microscope axis. Angles of rotation can be read to within 0.1° on the knob with graduation and vernier.

Brace-Köhler rotary compensator (41 37 31) (Fig. 9)
to measure phase differences up to λ/10. The calibration values for the wavelengths of the lines C', D, e and F' are given in the operating instructions of each compensator (designated by the number of the compensator).

λ/4 plate (47 37 18) for Sénarmont compensation
acts in conjunction with the rotary analyzer (47 36 62-9903). Its optical element is a quarterwave plate whose principal oscillation directions are parallel with those of polarizer or analyzer. To compensate the phase difference in the object the analyzer is turned by a certain amount and the angle of rotation read off. The measuring range is 1 λ (see operating instructions G 41-510/I).

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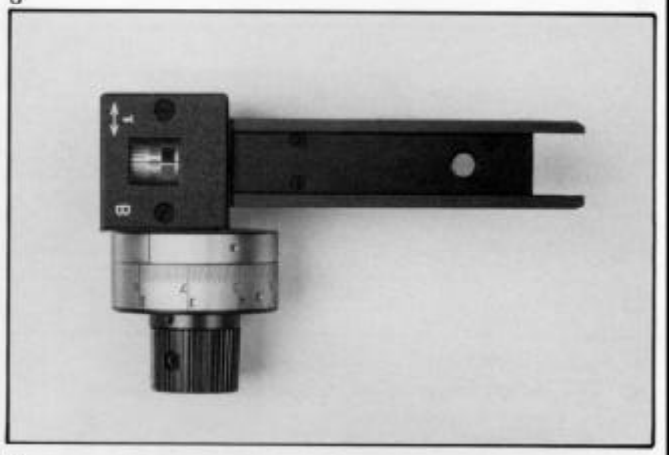

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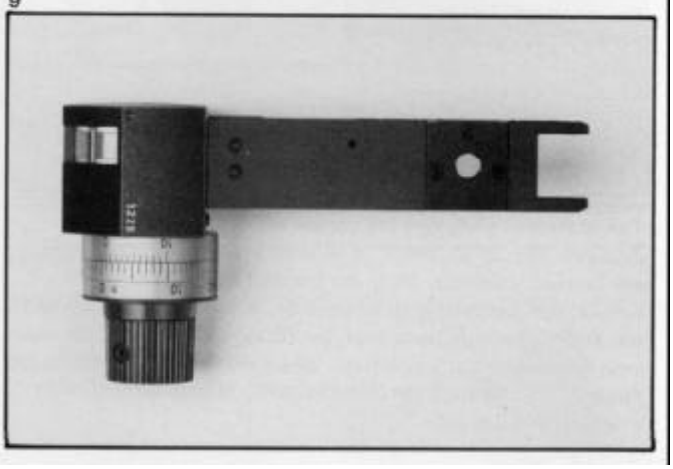

Exclusive microscope parts of Standard WL Pol

Mounting condenser carrier (10.2)
Flick up lever (**10**.3). Place the right guide ledge of the carrier against the rail (**10**.1). Swing the left side in until the spring bolt snaps in behind the guide ledge. Lower condenser carrier as far as it will go. Flick down lever and tighten it slightly.

Mounting specimen stage on change rail
With coarse focusing control (**11**.3) lower change rail as far as it will go.
Flick up lever (**11**.2) of stage carrier (**11**.1). Insert stage carrier from above in the change rail: let engage first the lower right projection, then the left spring bolt and at last the upper right projection. While doing so press the stage carrier against the change rail and lower it as far as the condenser carrier. Flick down lever.

Coarse/fine focusing control
It acts on the stage carrier. The motion of the coarse focusing control (**12**.4) can be stiffened or smoothened. Plug the supplied metal pin (**12**.1) into the borehole and turn it. The motion is stiffened when turning it in the direction of the arrow. Set fine focusing control (**12**.2) to a medium working range by turning the fine focusing control until dot (**12**.3) is embraced by the two index lines. Focus on the specimen first with the coarse focusing control (**12**.4) then with the fine focusing control; the fine focusing control will thus have the same clearance in either direction.
One full turn of the fine focusing control corresponds to a vertical stage movement of 0.1 mm (1 interval of its graduation corresponds to 0.002 mm = 2 μm).

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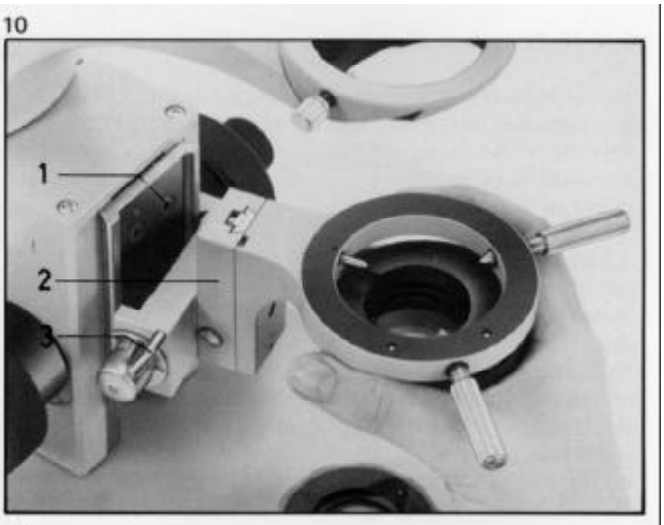

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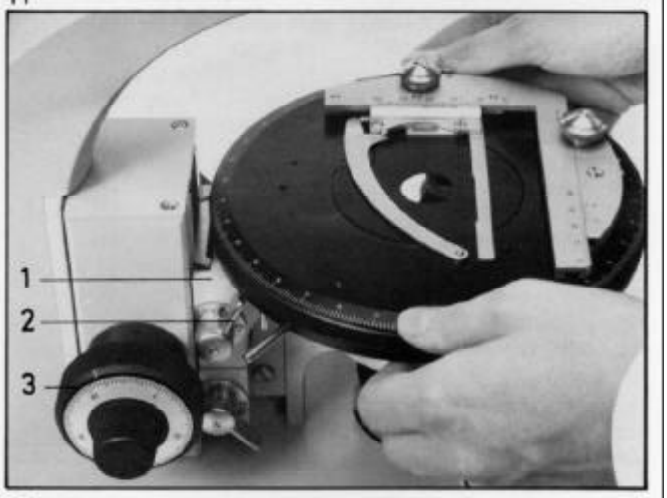

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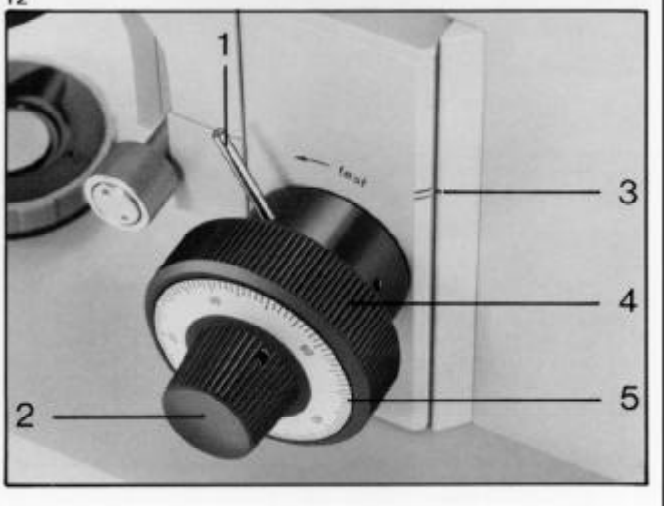

6 V 15 W in-base illuminator

Hold 6 V 15 W filament lamp (38 00 18-1740) (**13**.1) with a soft cloth and plug it into socket (46 80 10-9904) (**13**.2) so that the red dot is opposite the red pin. Push lamp in, turn it clockwise as far as it will go and let it snap in. Remove fingerprints on the bulb.

Turn clamping ring (**14**.2) until its red dot is opposite the red dot of the tube (46 70 50) (**14**.1). Slide filament lamp in socket (**14**.3) into collector tube and secure with clamping ring.
Before connection to the mains check whether the voltage set on the transformer corresponds to the local mains voltage. If this is not the case, set the right voltage or call our maintenance service.
Connect 6 V 15 W lamp to the mains by cable via transformer. Mains cable socket (**15**.3).

Transformer (39 25 24-9903) with voltmeter (Fig. 15)
100-110-115-127-220-240/2 . . . 8 V/50 ... 60 Hz, power consumption 30 VA, sockets (**15**.1) for two 6 V 15 W illuminators.
Switch on transformer with control (**15**.2) and with the same control adjust the brightness.
It is generally sufficient to run the filament lamp a undervoltage which increases its life. Run the lamp at overvoltage only for short periods.

Instead of transformer (39 25 24-9903) (Fig. **15**), step-up transformer (39 25 64-9903) can be used: adjusted for 100-127-220-240/3-4-5-6-7-8 V/50 ... 60 Hz, power consumption 25 VA, with CEE plug. The secondary voltage can be set in steps of 1 V. Only a 6 V 15 W lamp can be connected to its sockets. Switch-on with lever and brightness control by means of knob.

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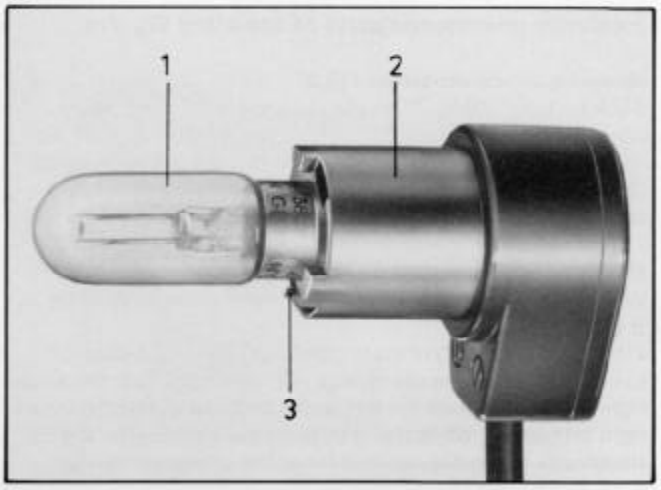

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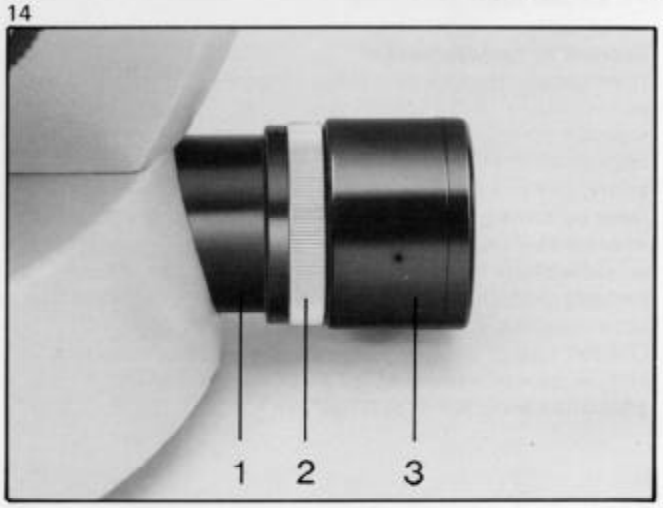

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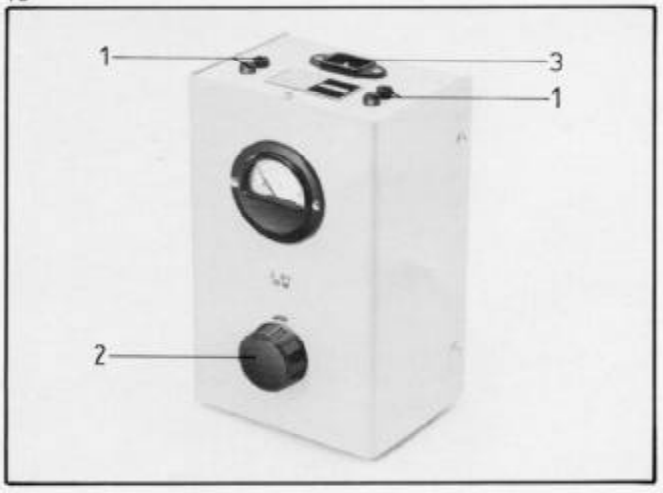

6 V 10 W in-base halogen illuminator

for Standard microscopes only

Screw auxiliary lens EL Pol (46 51 44) (**16**.2) from below into condenser (**16**.1).

Socket (**17**.3) for mains cable. In-base transformer for 220/ 9 V, 50 ... 60 Hz, max. power consumption 18 VA, protection class III complying with VDE regulations or in-base transformer for 120/9 V, 50 ... 60 Hz, UL-listed.

Fitting the 6 V 10 W halogen lamp

Put microscope on the side on a table. Loosen knurled screw (**17**.1) and pull out lamp socket (**17**.2). Pull defective lamp out of the two metal clamps (**18**.1). Hold new halogen lamp on plastic bag in which it is supplied and plug it into the socket. Remove fingerprints before they burn in.

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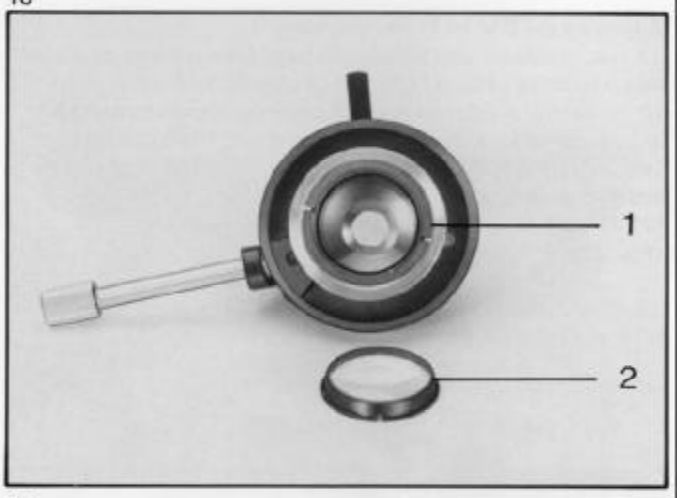

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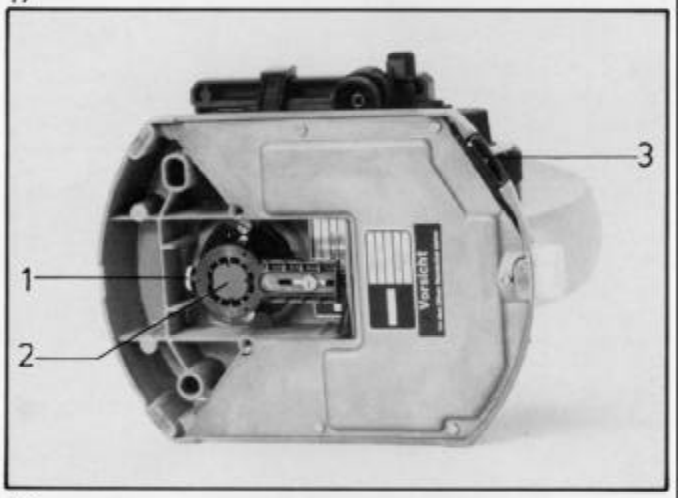

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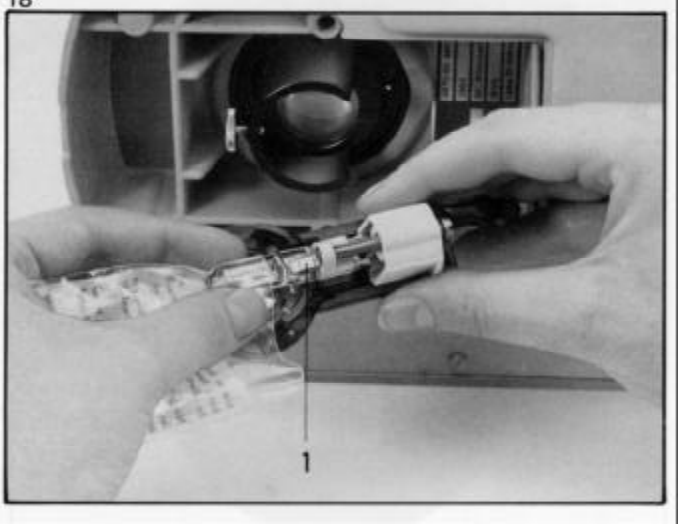

Adjusting the 6 V 10 W halogen lamp
To ensure correct adjustment the lamp filament and its mirror image must be of equal size and lie next to each other.
While watching lamp and concave mirror: loosen screw (**19**.1) so that the lamp socket can just be moved. Move socket with lamp until the lamp filament and its mirror image are next to each other (Fig. **20**). Tighten screw (**19**.1). Then turn screw (**21**.1) until lamp filament and its mirror are of equal size (Fig. **22**).

After adjustment insert lamp housing in diaphragm insert with ground glass and secure with knurled screw (**17**.1)

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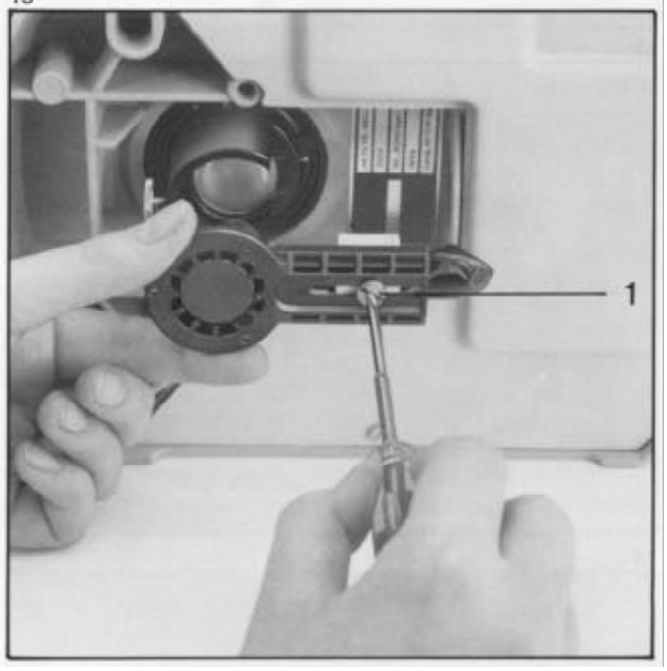

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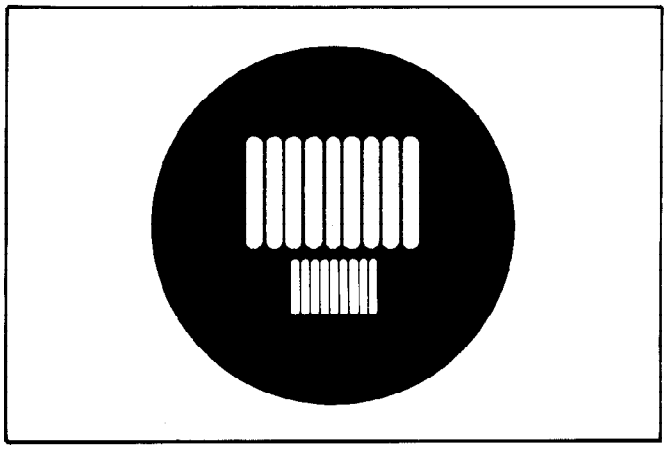

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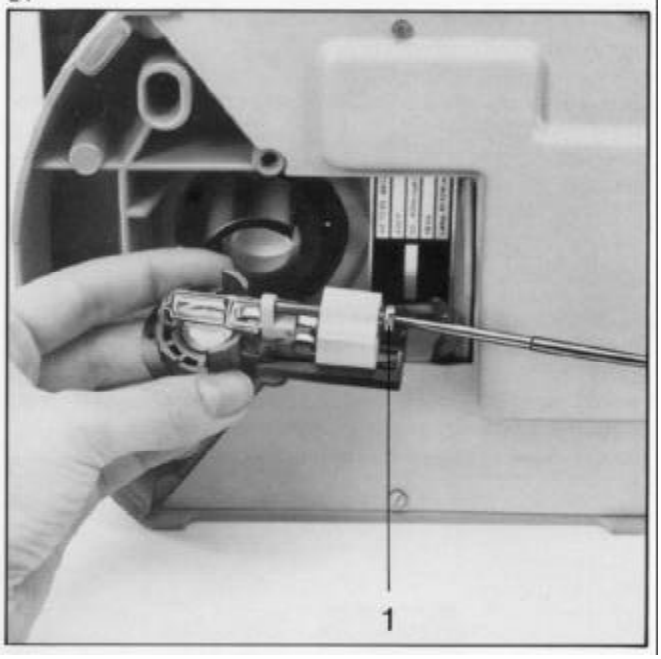

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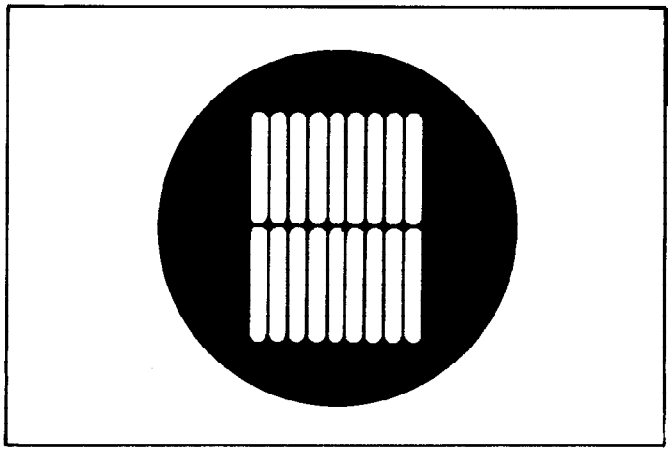

Microscope parts of Standard Pol and WL Pol

Mounting condenser (Fig. 23)
With coarse focusing control rack up microscope stage as far as it will go and with control (**1**.15) set condenser carrier to lowest position to provide ample space for insertion of the condenser. Press dovetail ring of condenser against spring bolt (**23**.1) and insert the condenser, rack it up to topmost position with control (**1**.15).

Mounting glide nosepiece on stand head with glide mount (Fig. 24)
Attach glide nosepiece with objectives slightly tilted so that at first ca. 2/3 of the rail with the loosened clamping screw (**24**.1) engage the guide. Swing the other guide rail up and slide the glide nosepiece into the glide mount as far as it will go. To move the glide nosepiece pull out the spring locking pin at the end of the knurled screw after having slightly loosened clamping screw (**24**.1).Then tighten clamping screw again.

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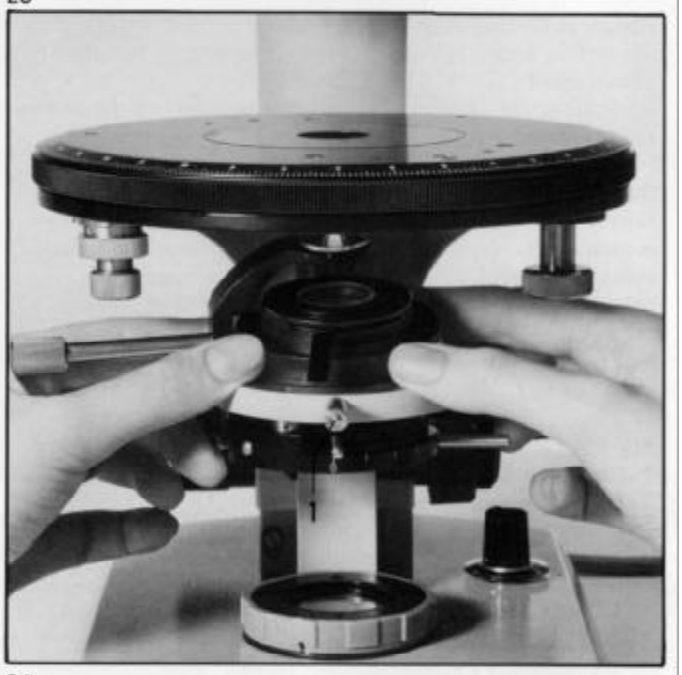

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Rotary polarizing stage
The rotary polarizing stage is firmly mounted on Standard Pol microscopes.
On Standard WL Pol microscopes it is mounted on the change rail by way of a stage carrier (47 15 40) (**25**.5).

Rotary polarizing stage (47 34 64) (3.8)
runs in precision ball bearing; dia. of stage area 150 mm; removable reducing plate. The stage features bores and tapped holes for: stage clips, attachable mechanical stage Pol (Fig. **26**), heating and cooling cell (47 80 13) and universal rotary stage. Its 360° graduation with vernier allows measurements of the angle of rotation to within 1/10°. The stage can be fixed in any desired position.

Fig. 25: Large rotary polarizing stage (47 34 66)
1 Control for stage rotation
2 Knob to engage and disengage control (1)
3 Lever to clamp the stage rotation
4 Knob to operate 45° click-stop system to change quickly between parallel and diagonal positions when working with auxiliary objects or compensators. It is operative when pulled out in any desired position, inoperative when snapped in at a click stop.
5 Stage carrier (47 15 40) to attach the specimen stage to the change rail (see Fig. **11**).

Attachable mechanical stage Pol (47 33 25-9903) and point counter (47 40 35)
To mount the attachable mechanical stage (**26**.4) use one tapped hole and 2 bores of the stage plate. By operating lever (**26**.6) standard-sized specimen slides (e.g. 76 x 26 mm, DIN 58 884 or 46 x 26 mm) can be moved within a 30 x 40 mm area and coordinates determined to within 0.1 mm within this area.

With the **point counter** 0.2 or 0.3 mm intervals are marked as the specimen is moved. Pulling out knurled knob (**26**.2) overrides the click stop. To mount the click-stop rings, loosen the three screws (**26**.1), take off ring (**26**.3) and fix click-stop rings (**26**.5).

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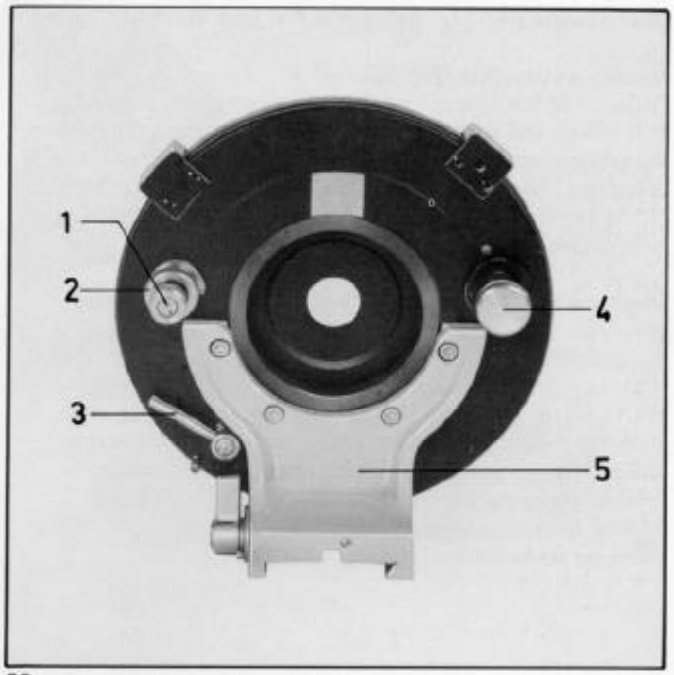

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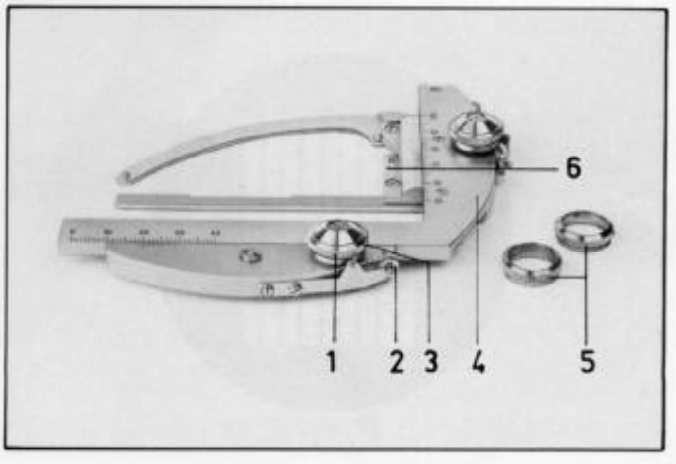

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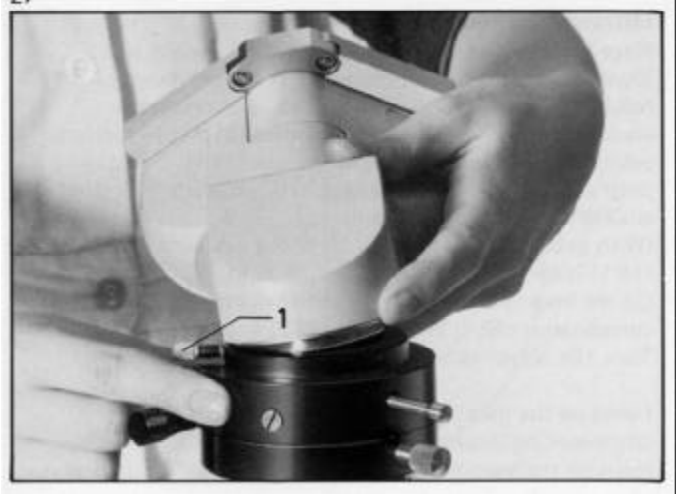

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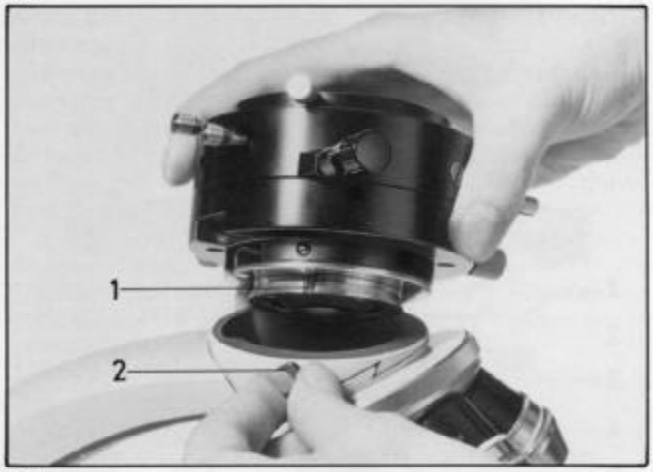

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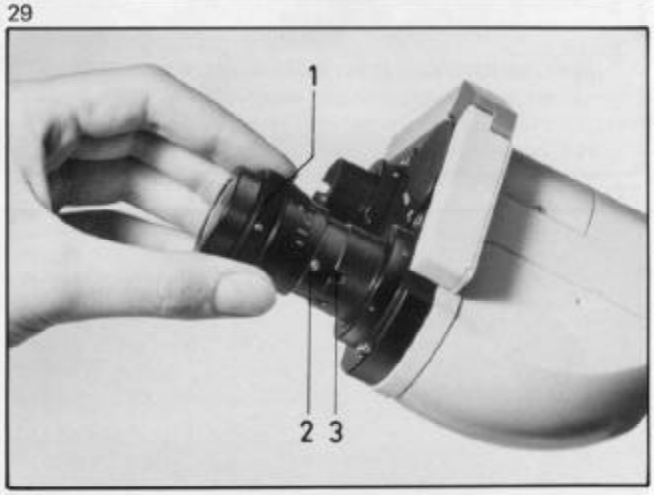

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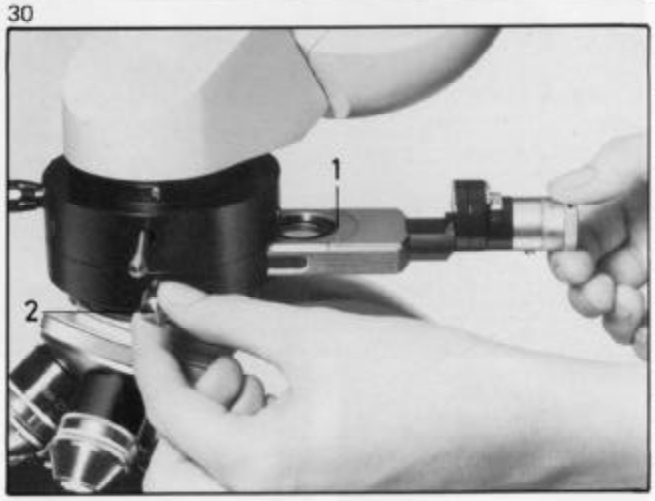


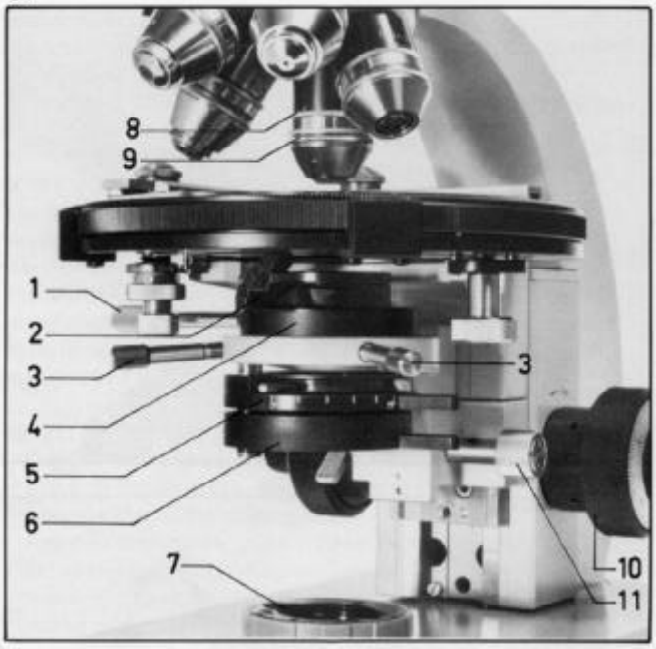
Fitting tubes (Fig. 27)
The viewing tube is fitted either directly on the stand head or above the intermediate tube (Fig. **27**) with its dovetails. The ring dovetails feature two 180° displaced notches (**28**.1) into which spring bolt (**28**.2) or (**27**.1) snaps in.
Tilt tube slightly, press its ring dovetail notch against the spring bolt of the loosened clamping screw (**27**.1) of the intermediate tube, and put on the entire ring dovetails until they snap in. Tighten clamping screw (**27**.1).
Mounting of the viewing tube either as shown in Fig. **1** or according to Fig. **2**.

Mounting intermediate tube on stand (Fig. 28)
As with the polarizing tube press down spring bolt (**28**.2) with one ring dovetail notch of intermediate tube (**28**.1), mount the tube completely and secure it with clamping screw.
The intermediate tube is correctly aligned when the slide-in direction of the analyzer slider (**30**.1) is SW-NO seen through the binocular polarizing tube. The analyzer is then aligned North-South in 90° position.

Focusing the eyepiece on the cross hairs
Look on a bright surface through Pol eyepiece (**29**.1) with reticle. Observe the cross hairs with relaxed eye. Turn diopter setting ring at first away from you and then towards you until the cross hairs are just in focus. Equip one of the tubes with Kpl eyepiece Pol (**29**.1) with reticle so that the alignment screw engages one of the two notches of the tube edge. Equip the other tube with a Kpl eyepiece with focusing eyelens (foc).

Slide in analyzer slider (Fig. 30)
Loosen knurled screw (**30**.2) and slide analyzer (**30**.1) into tube slot.

31



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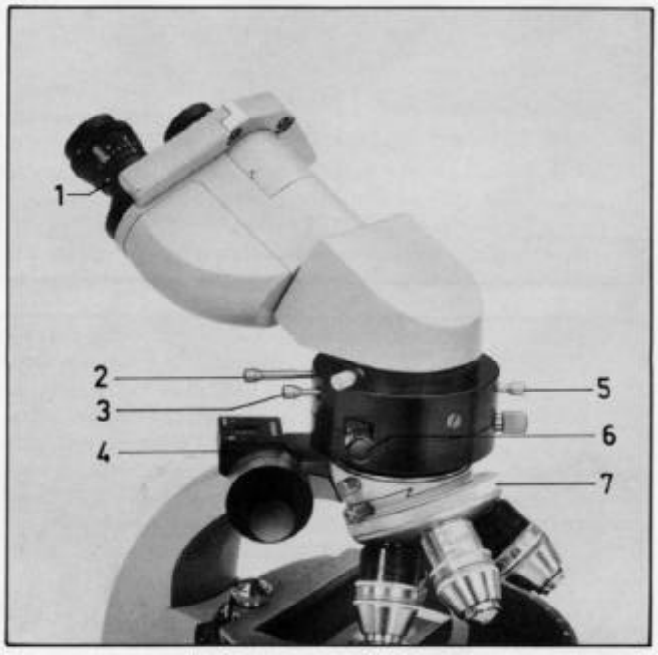

Orthoscopic image
Place specimen on rotary polarizing stage. Switch on illuminator and adjust brightness. Put neutral density filter NG 9 (46 78 26) on filter holder (**31**.7), if necessary.
Rack up condenser (**31**.4) with control (**31**.11) to topmost position. Swing in condenser front lens (**31**.1). Swing in polarizer (**31**.5) and let it engage in 0° position. Swing in auxiliary lens on carrier (**31**.6).
(With in-base illuminator 6 V 10 W the auxiliary lens EL (**16**.1) is screwed into the condenser in the factory.)
On the intermediate tube pull out analyzer, auxiliary object or compensator (**32**.4) and sliders (**32**.2) and (**32**.5).
Turn 10x objective into beam path.

Focus on the specimen
While looking through the eyepiece with adjusted reticle, focus on the specimen with control (**31**.10). With diopter ring of the eyepiece focus for the other eye.

Centering the Pol Z objectives (with centering rings)
The optical axis of the Pol objective must exactly coincide with the point of intersection of the eyepiece cross hairs. Turn specimen stage. If a feature in the cross-hair center changes its position, the objective must be centered.

Centering procedure: Move a prominent feature (**33**.1) with the attachable mechanical stage to the objective-axis position, e.g. (**33**.2). From this point move the feature (**34**.1) to the cross-hair center by slightly turning centering rings (**31**.8 and **31**.9). (Do not turn both centering rings in the same direction).

The objective is centered when the feature (**35**.2) remains in the cross-hair center while the stage is turned. All other features like (**35**.1 and **35**.2) move on concentric circles about the cross-hair center. If this is not the case, repeat the centering procedure.

Center one objective after the other in this manner. To turn in another objective, hold the nosepiece on its knurled ring (**32**.7) and do not touch any objective to avoid decentering.

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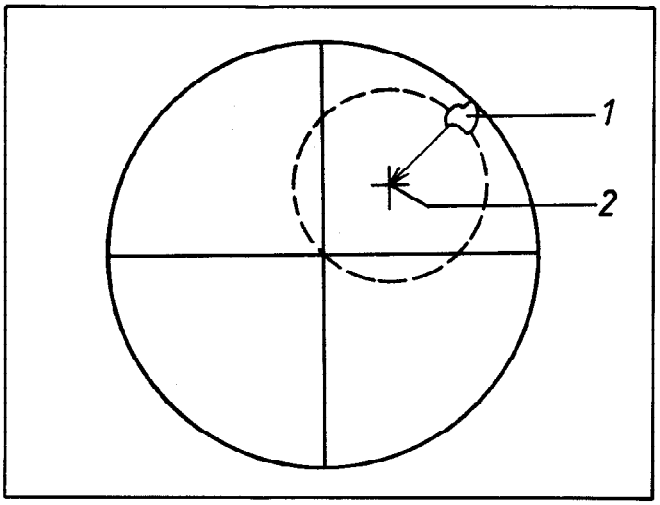

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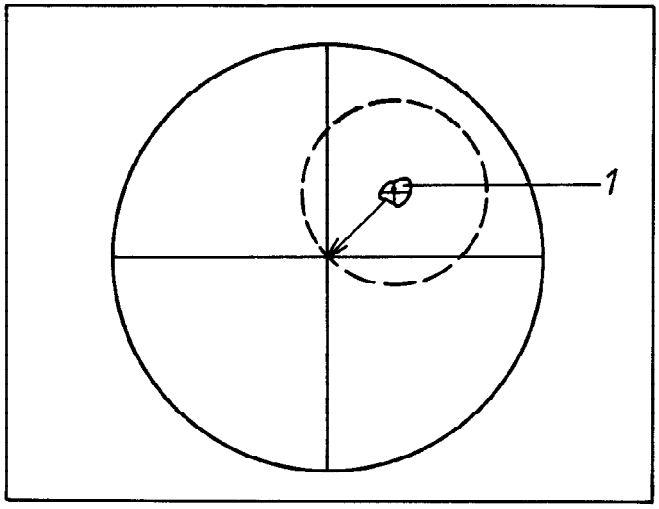

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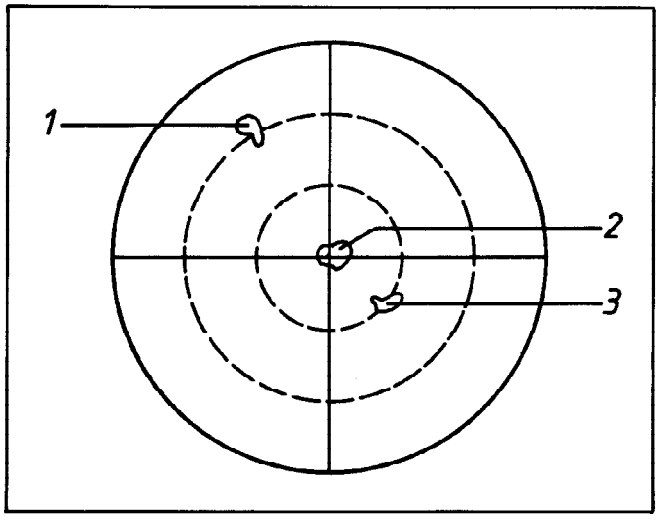

Adjust Köhler illumination
While looking through the tube close luminous field diaphragm (**31**.7) about one half. Set condenser to focusing position with knob (**31**.11), i.e. focus the image of the luminous field diaphragm in the object plane (Fig. **36**). Center this image with screws (**31**.3) (Fig. **37**), open luminous field diaphragm until its image just illuminates the field of view (Fig. **38**).

Observation of the aperture diaphragm

1. With diopter (46 48 89) in case of normal monocular or binocular tube. Plug the diopter into the tube instead of one eyepiece.
2. Through the swung-in Bertrand lens (**3**.2) in case of the monocular polarizing tube (**3**.1).
3. With swung-in Bertrand optics (**32**.5) and diaphragm (**32**.2) in case of intermediate tube (47 30 56) (Fig. **32**). Focus the aperture diaphragm with knob (**32**.6).

Adjusting the aperture diaphragm
Close aperture diaphragm (**31**.2) until its image frees about 2/3 (Fig. **39**) of the objective exit opening. Closing the diaphragm further increases the contrast but reduces resolution. It is recommended to check and/or correct the aperture-diaphragm setting after objective change.

(For a small convergence of the illuminated light bundles the aperture diaphragm must be closed further. This is necessary, for instance, to determine the extinction direction of anisotropic crystals, to observe a high-contrast Becke line, or to increase the black-and-white or color contrast between crossed polarizers.)

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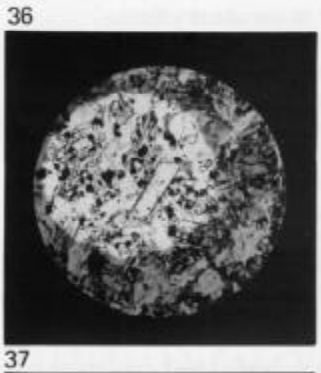

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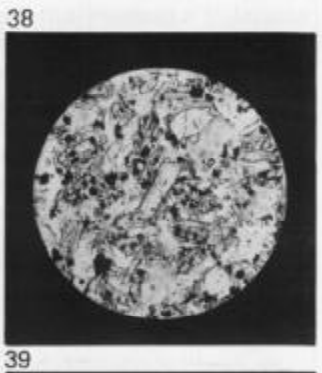

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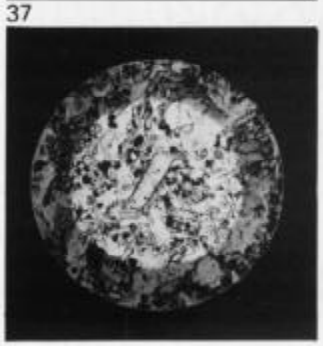

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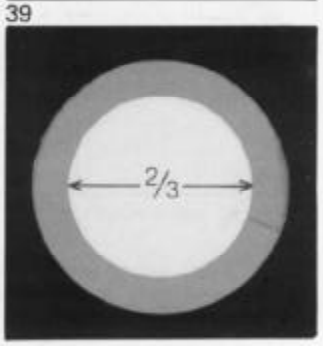


Alignment of polarizer and analyzer
The reference direction is East-West.
The pre-aligned oscillation direction of a non-rotary polarizer is East-West.
The oscillation direction of a rotary polarizer is East-West if its angle scale is set to 0°.

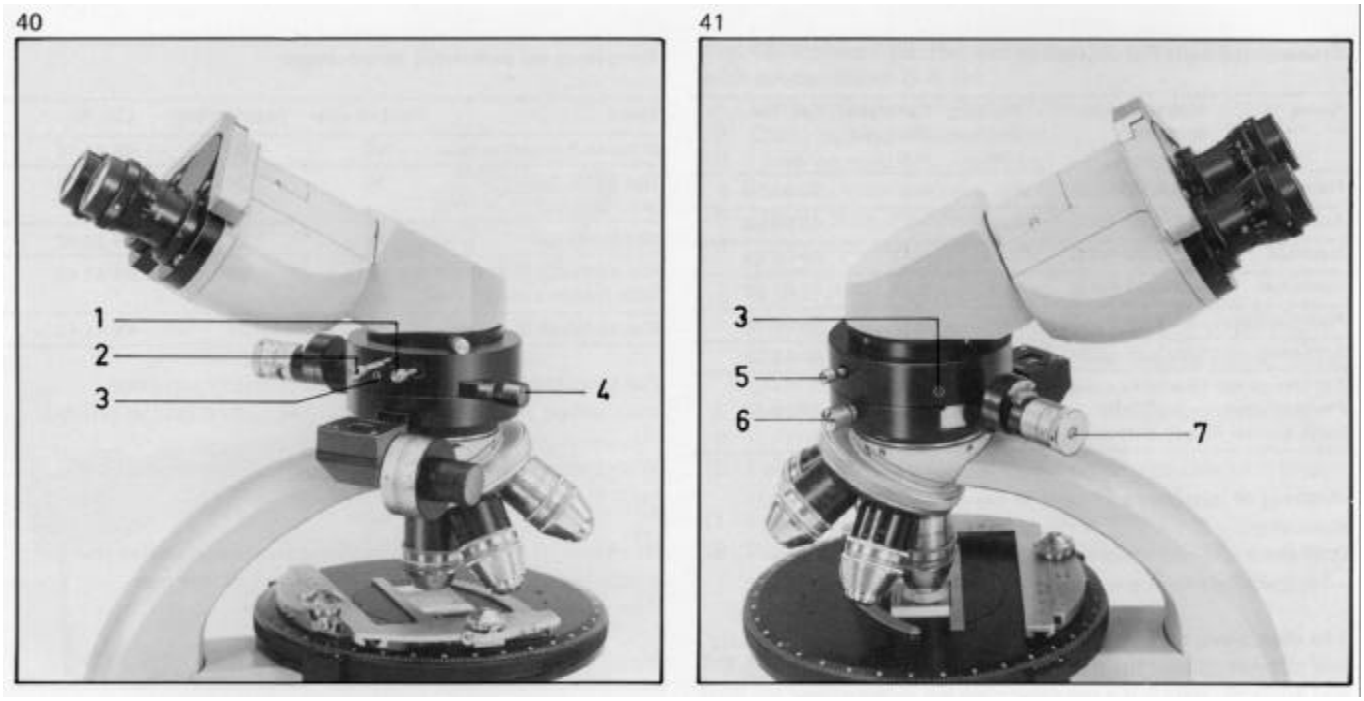
The pre-aligned oscillation direction of a fixed analyzer is perpendicular to that of the polarizer. The pre-aligned oscillation direction of a rotary analyzer (**30**.1) is parallel with that of the polarizer if its angle is set to 0°, or crossed if it is set to 90°. Swing polarizer and analyzer into the beam path.

Working with low-power objectives
Planachromat 2.5/0.08 Pol objective (46 01 18) images a large object field; to fully illuminate this field the condenser front lens must be swung out.
Auxiliary lens (**31**.6) remains in the beam path. Diaphragm (**31**.7) acts as aperture diaphragm.
An exceptionally large object field is covered by the Planachromat objective 1.25/0.04 (46 20 14). For its illumination remove the condenser and swing in auxiliary lens (**31**.6). Diaphragm (**31**.7) acts as aperture diaphragm.

Working with oil immersion objectives
Only when the supplied oil is used can the capabilities of the immersion objectives be fully utilized. Avoid air bubbles on the specimen during immersion, because they would impair the image. Swing objective out of the beam path and apply a drop of immersion oil to the coverglass. Turn immersion objective into beam path. Carefully focus with fine focusing control. It is generally sufficient to use the dry Pol condenser.
The immersed condenser Pol, aperture 1.3 (46 52 63) is required to cover the conoscopic image under the largest possible aperture angle. With the oiler apply a drop of immersion oil to the condenser front lens, so that front lens and specimen slide bottom are connected by the oil. After termination of the examination remove the oil from all surfaces with a clean, soft cotton cloth and optical detergent solution from the kit (43 90 07).

Conoscopic image (interference figure)
Adjust specimen for orthoscopic observation (see p. 16) and move it to the center of the cross hairs. Turn in suitable Pol objective of high aperture (25x or higher). Open luminous field diaphragm and condenser (aperture) diaphragm. Polarizer and analyzer must be in crossed position. On the intermediate tube (Figs. **40/41**) slide in Bertrand optics in slider (**41**.5).
Focus the interference figure with knob (**40**.4). (Write down the number of the finder scale for the corresponding objective.) Select the best pinhole diaphragm with slider (**40**.1). If desired, cut off orthoscopic image in the environment of the conoscopic image with slider (**40**.2) Center the interference figure to the point of intersection of the reticle with the supplied hex socket wrenches and the hex socket screws (**40**.3) and (**41**.3).

On the monocular polarizing tube (**3**.1) swing in Bertrand lens and diaphragm withknob (**3**.2) and observe the interference figure.



The oscillation directions of the orthoscopic image and the character of birefringence of the conoscopic interference image are indicated in the table below

Reference directions with auxiliary objects and compensators	Conscopic adjustment						Orthoscopic adjustment	
	optically uniaxial section perpendicular to the optical axis		optically biaxial section perpendicular to the acute bisectrix				addition position	subtraction position
			cross position		diagonal position			
	+	−	+	−	+	−		
λ plate								
During insertion of quartz wedge 0-3 λ and tilting of compensators B and E							higher interference colors*	lower interference colors*
Auxiliary object λ/4								

Displacement direction of interfrence fringes in the conoscopic image

$n_{\gamma'}$ in the object

*The indicated colors of the orthoscopic image are examples which are given when first order white is visible without auxiliary object

Objectives Pol Z, Pol eyepieces
Total magnification

Transmitted-light Pol objectives

Name	Magnification/ aperture	Working distance mm	Coverglass thickness mm	Cat. No.
Planachromat	2.5/0.08 Pol Z	8.5	–	46 01 18
Achromat	10/0.22 Pol Z	5.0	–	46 04 08
Neofluar	25/0.60 Pol Z	0.54	0.17	46 06 28
Achromat	40/0.85 Pol Z	0.36	0.17	46 07 08
Plan-Neofluar	63/0.90 Pol Z	0.09	0.17	46 08 18
Achromat	100/1.25 oil Pol Z	0.09	0.17	46 19 08
For low-power observation and photomicrography:				
Planachromat (with normal 45 mm parfocal length)	1.25/0.04	4	–	46 20 14

Meaning of numbers and signs in the column coverglass thickness:
0.17 cover the objective by an 0.17 mm thick coverglass
– specimen can be used with or without coverglass

The objectives designated Pol contain strain-free lens elements and dot not change the polarization state between polarizer and analyzer, which is a pre-condition for exact phase-difference measurements with compensators.
The designation Pol Z refers to transmitted-light objectives in centering mount.
The Pol Z objectives 25x, 40x and 63x have exceptionally high apertures and are therefore particularly well suited for conoscopic examination.

The total magnification of the microscope results from the multiplication

$M_{microscope} = M_{obj} \times M_{eyep}$

for example: 400 = 40 x 10

Meaning of abbreviations:
M_{obj} = objective magnification, here 40x

M_{eyep} = eyepiece magnification, here 10x

Eyepieces for polarizing microscopes

Name	Field of view	Angular field	Cat. No.
C 8x/16 Pol with reticle	16	30°	46 39 15
Kpl 8x/18 Pol with reticle	18	33°	46 39 25
Kpl 8x/18 foc	18	33°	46 39 23
Kpl 12.5x/18 W Br Pol with crossline micrometer	18	48°	46 41 45
Kpl 12.5x/18 W Br foc	18	48°	46 41 43

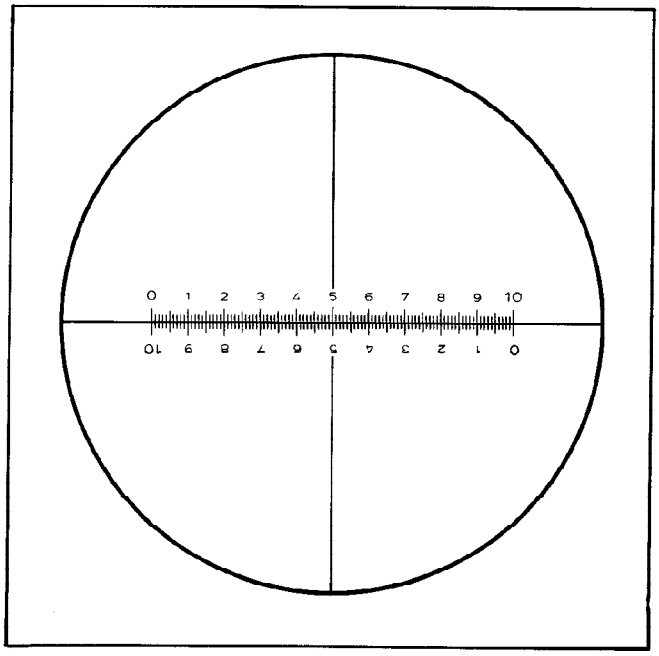
Pol eyepieces contain a pre-aligned reticle or crossline micrometer (Fig. 42) and a screw (32.1) to align the reticle.

With the wide fields of view of **wide-angle eyepieces (W)** large-diameter object fields can be surveyed.

Br eyepieces are high-eyepoint eyepieces which offer the eyeglass wearer the same wide field of view the non-eyeglass wearer enjoys.

Eyepieces foc come with diopter setting rings.

Fig. 42: Eyepiece crossline micrometer



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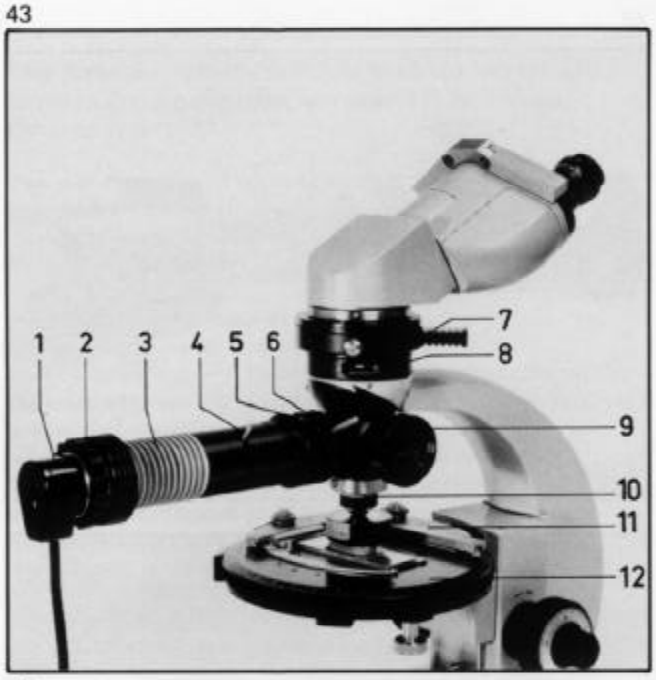


Fig. 43: Standard WL Pol microscope with epi-condenser II A ore

1 Lamp socket with 6 V 15 W filament lamp
2 Clamping ring of lamp socket
3 Lamp housing with clear-glass lamp condenser
4 Lever to open and close the aperture iris diaphragm
5 Filter holder for 32 mm dia. light filters in holder
6 Swing-in polarizer; in the beam path its oscillation direction is East-West
7 Slider (47 36 63-9903) with analyzer slid into large tube slot. Its oscillation direction is North-South. When the slider is completely pulled out a quartz plate will be in the beam path.
8 Receptacle for auxiliary object or compensator on slider
9 H-Pl reflector (46 62 65)
10 Epiplan Pol objective on centering change ring with thread W 0.8 (46 62 56)
11 Attachable mechanical stage Pol (47 33 25-9903)
12 Rotary polarizing stage (47 34 66) running in ball bearing, with click-stop system to mark 45° angles of rotation, on attachable stage carrier (47 15 40)

44

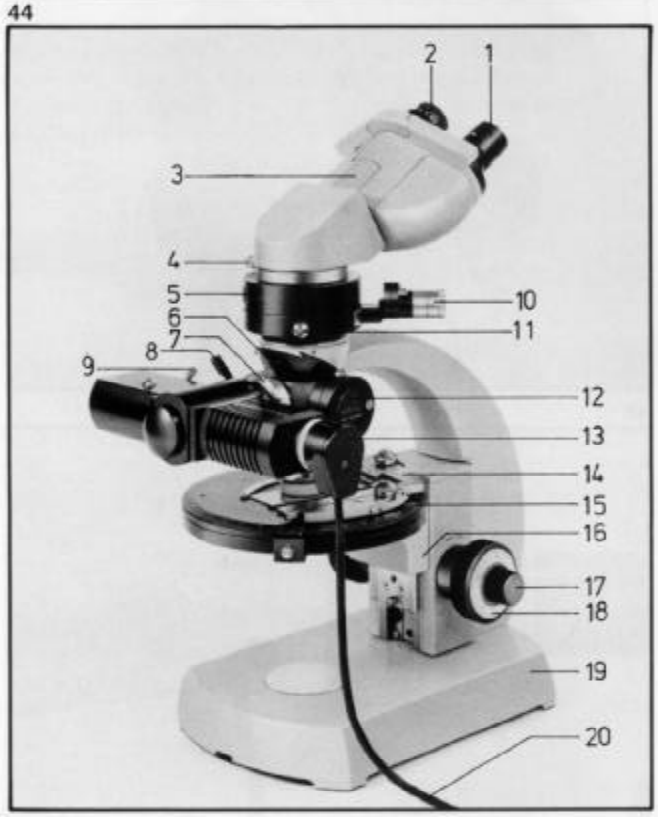
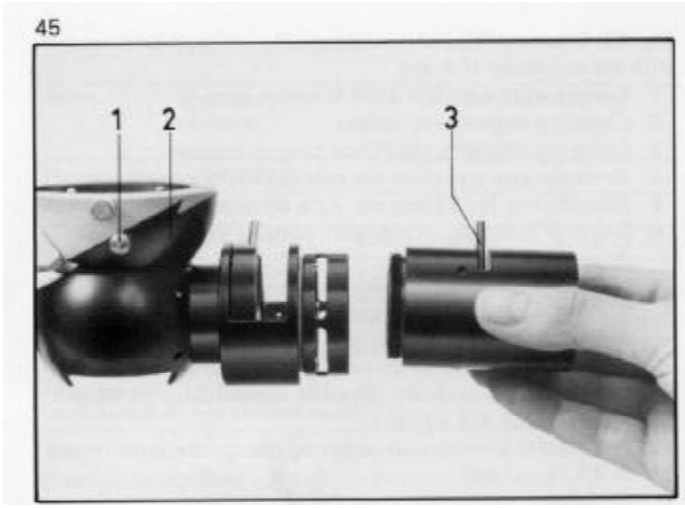
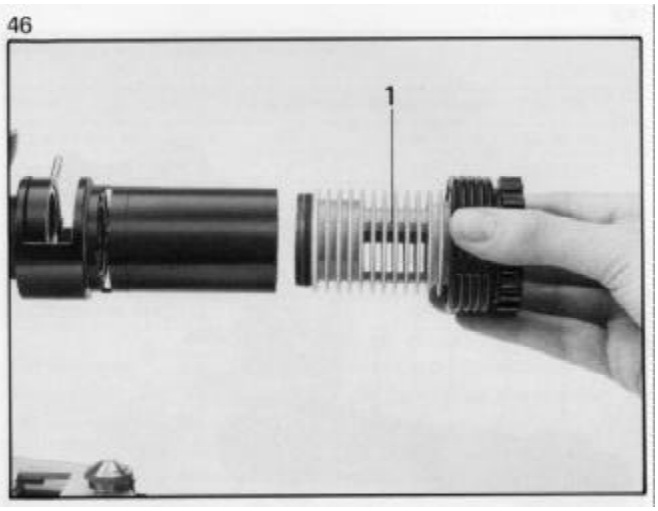


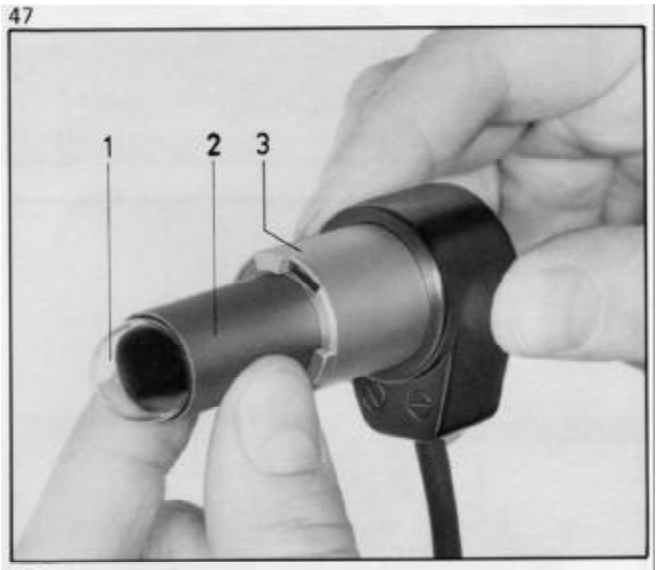
Fig. 44: Standard WL Pol microscope with epi-condenser II ST ore

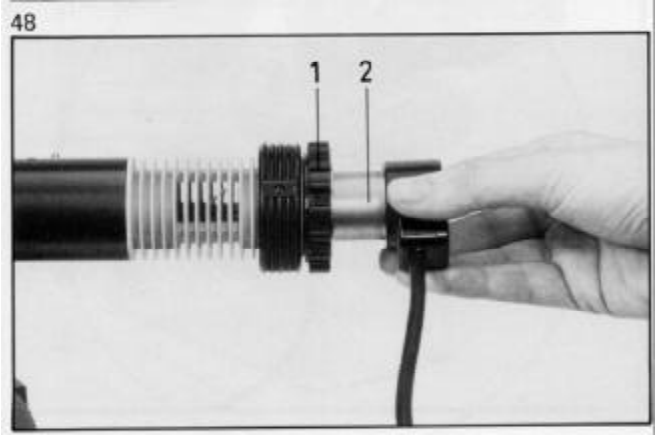
1 Kpl wide-angle focusing eyepiece 12.5x/18 Pol Br with crossline micrometer (46 41 45)
2 Kpl wide-angle focusing eyepiece 12.5x/18 Br (46 41 43)
3 Binocular tube S 30° Pol (47 30 36) with reticle erection system
4 Clamping screw of tube
5 Intermediate tube (47 30 59-9902)
6 Epi-condenser II ST ore (48 64 86)
7 Incident-light polarizer (47 36 16) Pre-aligned, rotatable through 90°, oscillation direction East-West in 0° position, lockable
8 Lever with the position H and D for brightfield and darkfield illumination
9 Centering screws of aperture diaphragm
10 Slider with rotary analyzer (47 36 62-9903)
11 Clamping screw of analyzer slider
12 H-Pl Pol reflector (46 62 65)
13 Lamp socket with 6 V 15 W filament lamp
14 Attachable mechanical stage Pol (47 33 25-9903) to move the specimen within a 30 x 40 mm area
15 Rotary polarizing stage (47 34 64) with graduation and vernier and clamping device
16 Attachable stage carrier (47 15 40)
17 Fine focusing control
18 Coarse focusing control
19 Standard WL stand
20 Cable for connection of lamp and transformer

For Standard 04 or 06 Pol microscope with incident-light accessory (46 63 21) see operating instructions G 41-505.









Clamp attachable stage carrier with specimen stage to change rail of Standard WL microscope (see p. 9).

Mounting epi-condenser on stand head with glide mount (Fig. 45)
Mount epi-condenser (**45**.2) slightly tilted, so that at first ca. 2/3 of the rail engage the guide with the clamping screw (**45**.1). Then swing in the other rail and slide the epi-condenser in as far as it will go. When sliding the epi-condenser into or out of the glide mount, pull out the spring locking pin at the end of the knurled screw after having slightly loosened clamping screw (**45**.1).
Secure epi-condenser with clamping screw.

Screw aperture diaphragm part (45.3) to epi-condenser II A

Screw lamp housing with lamp condenser (46 72 55) (**46**.1) to aperture diaphragm part.
Hold **6 V 15 W filament lamp** (38 00 18-1740) (**47**.1) with a soft cloth and plug it into socket (46 80 10-9904) (**47**.3); red dot must be opposite red pin. Press down lamp, turn it clockwise as far as it will go and let it snap in. Remove fingerprints on the glass bulb. Slide sleever (**47**.2) over lamp. Turn clamping ring (**48**.1) so that its red dot is opposite the red dot of the lamp housing with lamp condenser.
Slide filament lamp in socket (**48**.2) into lamp housing and secure with clamping ring.
Connect 6 V 15 W lamp to the line by cable via transformer.

Slide in reflector (Fig. 49)
Slide plane-glass reflector H-Pl Pol (46 62 65) into epi-condenser so that pin (**49**.1) engages notch (**49**.2). Tighten clamping screw (**49**.3).

The H-Pr Pol prism reflector (46 62 61) is recommended for examinations of weakly anisotropic substances. Its image brightness is considerably higher than that of the plane-glass reflector (see p. 26).

Screw Epiplan Pol objective (50.3) into centering change ring
Insert change ring with Epiplan Pol objective from the side in the dovetail guide (**50**.1) and turn it backwards as far as it will go. For mounting of intermediate tube, binocular Pol tube, and eyepieces, and slide-in of analyzer see the corresponding instructions for the transmitted-light polarizing microscopes (p.15).
The tube slot for auxiliary objects becomes accessible when a lever is slid to the left.

Either an East-West-aligned, swing-in polarizer (46 62 89) (**43**.6) is firmly mounted on the epi-condenser, or a rotary polarizer (47 36 16) (**51**.2) inserted in the filter holder so that pin (**51**.1) engages notch (**51**.3).
Turn polarizer to 0° position and secure with knurled screw (Fig. **51**); its oscillation direction is East-West.
The second filter holder accepts a 32 mm dia. filter in holding ring (46 72 52).

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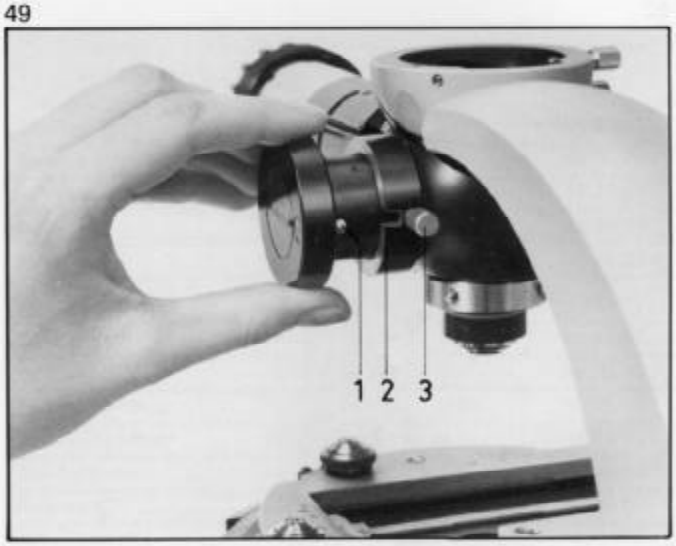

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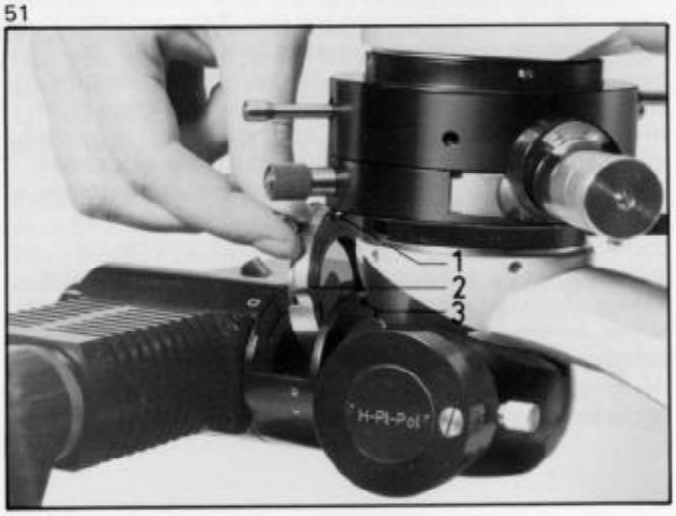

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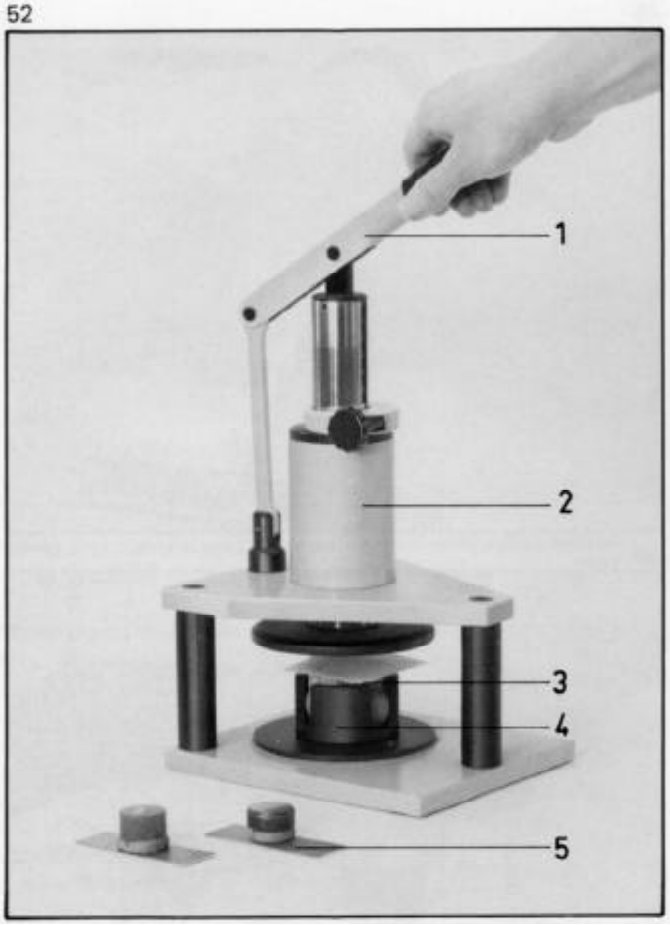

Preparations

Place polished section on pot (**52**.4) filled with plasticine or on a specimen slide with plasticine and align it perpendicular to the microscope axis by pressing down lever (**52**.1) of the levelling press (47 89 62) (**52**.2). The polished section to be aligned is shown in Fig. **52** covered by a sheet of tissue paper to avoid scratches on the surface. Polished sections on normal specimen slides (**52**.5) can be aligned with the levelling press in the same manner. Fix specimen in the specimen holder on the specimen stage. Connect microscope illuminator with transformer. Before mains connection check whether the voltage set on the transformer coincides with the local mains voltage. If not, set the correct voltage or call our maintenance service. Switch on transformer and adjust brightness. Set polarizer to 0°, mount Epiplan Pol objective (e.g. 16x) on the epi-condenser. Swing analyzer and auxiliary object out of the beam path.

Focus on the specimen

70 mm are the maximum height of specimens (distance between stage top surface and focusing plane) which can be examined under a Standard WL incident-light microscope (Figs. **43** and **44**).

Microscopes Standard 08 and 18 with glide mount on the stand head can be used with the same equipment. The maximum specimen height is 15 mm.

Remove Pol eyepiece (**44**.1) from the tube, hold it against a bright surface and watch the reticle, thereby leaving your second eye open. Turn out the eyepiece as far as it will go, then turn it in from + towards − until the reticle is just in focus.

The user's diopter value is then indicated by the red dot on the diopter scale.

Plug Pol eyepiece into tube so that the alignment screw engages the horizontal notch. Focus on the specimen with control (**44**.17) and correct the focus for the other eye with eyepiece (**44**.2).

Center Epiplan Pol objective

Plug centering devices on to two pins (**50**.2) and center the Pol objective so that its optical axis and the center of rotation of the specimen stage coincide with the point of intersection of the reticle cross hairs of the eyepiece (see p. 16).

Adjust aperture diaphragm

The image of the aperture diaphragm becomes visible in the exit opening of the objective when the eyepiece in the tube is replaced by diopter (46 48 89), or, when with the intermediate tube, the Bertrand optical system is brought into the beam path (Fig. **32**) (see p. 17).

Adjust aperture diaphragm of epi-condenser II ST with knurled control (**50**.5) and center it with knurled screws (**50**.4).

Adjust aperture iris diaphragm of epi-condenser II A with lever (**43**.4).

Close aperture diaphragm so far that its image releases ca. 4/5 of the objective exit opening. Closing the diaphragm further improves the contrast but reduces the resolution. Check and/or correct the aperture diaphragm adjustment after objective exchange. Insert eyepiece in tube or swing Bertrand optical system out of the beam path.

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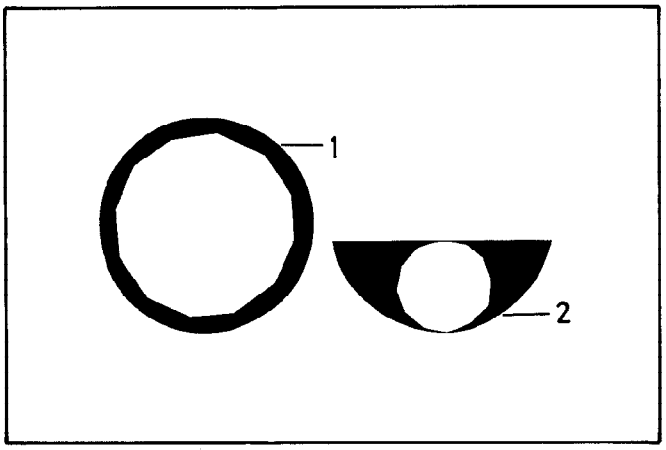

Fig. 53: Aperture-diaphragm images in objective aperture
1 with H-Pl Pol plane-glass reflector
2 with H-Pr Pol prism reflector

Cross incident-light polarizer and analyzer
Slide in analyzer (**43**.7) or set rotary analyzer (**44**.10) to 90°. Swing in polarizer (**43**.6) or set polarizer (**44**.7) to 0°. It may be necessary to turn it slightly until a strongly reflecting isotropic phase of the specimen, or, better a surface mirror appears black. Set lamp to maximum brightness. Focus on a highly anisotropic object. Four times darkness and four times brightness must appear during stage rotation, and the dark and bright specimen phases must re-appear exactly every 90° stage rotation. If, for instance, only 2 bright phases are observed during a stage rotation through 360°, the wave trains coming from the polarizer are not aligned perpendicular to the reflection plane of the reflector.
Polarizer and analyzer must then be turned synchronously by slight amounts until the above-mentioned phenomena are observed.

For the total magnification of the microscope see p. 20.

Dry objectives	Magnification/ aperture	Working distance mm	Cat. No.
Epiplan	4/0.10 Pol	9.0	46 20 01
Epiplan	8/0.20 Pol	7.1	46 20 02
Epiplan	16/0.35 Pol	3.1	46 20 03
Epiplan	40/0.85 Pol	0.23	46 20 04
Epiplan	80/0.95 Pol	0.09	46 20 80
Immersions objectives			
Epiplan	4/0.10 oil Pol	0.3	46 20 06
Epiplan	8/0.20 oil Pol	0.3	46 20 07
Epiplan-Neofluar	16/0.50 oil Pol	0.32	46 15 76
Epiplan-Neofluar	25/0.80 oil Pol	0.38	46 16 76
Epi-Achromat	40/0.85 oil Pol	0.5	46 20 09
Epiplan	100/1.25 oil Pol	0.25	46 20 05
Objectives with long working distances			
LD-Epiplan	16/0.30 Pol (covergl.thickn.1.5)	4.1	46 21 23
LD-Epiplan	40/0.60 Pol (covergl.thickn.1.5)	3.4	46 21 24
Cap	LD 16 Pol (covergl.thickn.0)	3.3	46 29 15
Cap	LD 40 Pol (covergl.thickn.0)	2.4	46 29 16

Epiplan Pol objectives
contain strain-free lens elements, which ensures that the polarization state between polarizer and analyzer is not changed.

LD-Epiplan objectives (coverglass thickness 1.5) have long working distances. They are used with LD-caps (coverglass thickness 0) for uncovered, opaque specimens.
Mounting the LD-cap: unscrew aluminum ring of LD-Epiplan objective. Pull chromium-plated sleeve off the objective. Plug LD-cap (coverglass thickness 0) of the objective on the objective mount. Screw on aluminum ring.

Epiplan Pol oil immersion objectives produce maximum contrast even at low magnifications thanks to the immersion. When changing between high and low magnifications by exchanging the objectives the specimen need not be cleaned. The contrast conditions are the same at all magnifications.

Each Epiplan Pol objective requires a centering change ring (46 62 56) (Fig. **50**) for mounting on the epi-condenser.

H-Pl Pol and H-Pr Pol reflectors

The characteristics of the H-Pl Pol (Fig. **54**) and H-Pr Pol (Fig. **55**) reflectors used in epi-condensers II A (46 62 30) and II ST (46 62 15-9901) for incident-light microscopy in polarized light are listed in the table below.

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	H-Pl plane glass reflector, Vickers licence (46 62 65)	**H-Pr Pol prism reflector (46 62 61)**
Resolving power of the objective	fully utilized	better resolution of structures normal to prism edge
Illumination aperture	fully utilized	up to 50 % objective aperture
Specimen illumination	practically perpendicular	unilateral oblique illumination
Image brightness	losses through beam splitting; efficiency noticeably spectrum-dependet (selective), e.g. photometry	higher
Illumination of total field of view in unpolarized or singly polarized light	uniform	with high-aperture objectives slight vignetting at upper and lower edges of image
Extinction of entire field of view with crossed polarizer and analyzer	homogeneous	homogeneous
Preferred use	observation in polarized light, photomicrography	weak anisotropy low reflection

Further relevant operating instructions

K 41-003	Handbook of incident-light microscopy
G 41-119/I	Standard microscope with 6 V 10 W in-base halogen illuminator for transmitted light
G 41-120/I	Standard and Standard WL microscopes with 6 V 15 W in-base transilluminator
G 41-310/III	Microscope illuminator 100
G 41-415	MC 63 attachment camera
G 41-417	MC 63 A attachment camera
G 41-505	Standard 04 Pol microscope
G 41-510/I	Sénarmont compensators
G 41-511	Auxiliary objects λ and λ/4
G 41-516	Brace-Köhler compensators
G 41-521	Tilting compensator B, measuring range 5 λ
G 41-523	Tilting compensator E, measuring range 20 λ
S 41-500.0	Michel-Lévy color chart
A 41-656.1	Antiflex Device